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Issues in empirically modelling systemic risk

Conference Presentation

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Issues in Empirically Modelling Systemic Risk

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http://www.RiskResearch.org

New systemic risk centre at LSE

- Funded by the ESRC
- I am co–director along with Jean–Pierre Zigrand
- Formal start expected in November

Papers

- with with Kevin R. James, Marcela Valenzuela and Ilknur Zer
  - "Model Risk of Systemic Risk Models"
  - "Dealing With Systemic Risk when We Measure It Badly"
- with Hyun Song Shin and Jean–Pierre Zigrand
  - "Endogenous and Systemic Risk"
  - "Endogenous Extreme Events and the Dual Role of Prices"

Proliferation of systemic risk measures

- Office of Financial Research, January 5, 2012, *A Survey of Systemic Risk Analytics*, Bisias, Flood, Lo and Valavanis survey 31 SysRisk measures
- Many new since then

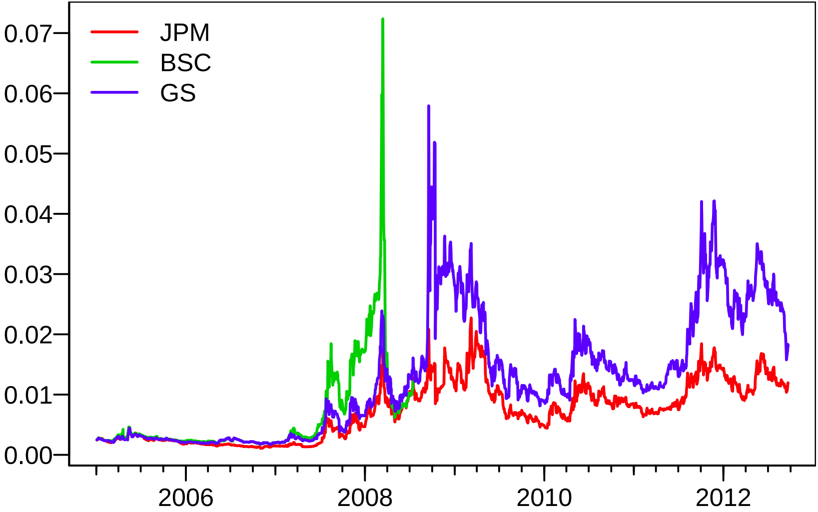
Some approaches

- Accounting and balance sheet information
- Interbank and other network linkages
- Exposure
- Financial market data
    - equity markets
    - bonds and CDS

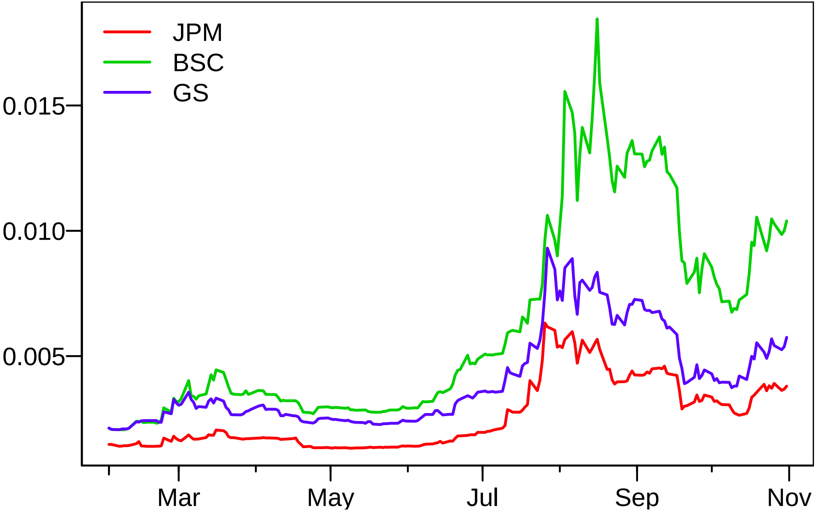
Key questions

1. Can a systemic risk measure beat the Financial Times?
   - Every indicator seems to flash at the same time
2. Is 2007/ 2008 really the right benchmark?
   - We don't know the nature of the next crisis, but it will be different from this one
   - Excessively calibrating models and analysis to 2007/2008 not advisable

CDS



CDS 2007



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Credit crisis to worsen as banks cut and run

The fallout from the crisis at two **Bear Stearns** hedge funds i

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FT ALPHAVILLE July 10, 2007

Remember that subprime crisis? Well, it's back

Systemic risk models that build on existing market risk methodologies

some might say they failed before the crisis, but...

Systemic risk from market risk models

- R_i is risky outcomes of institution i
- R_S is outcomes from the entire financial system
- Joint distribution is:

$$f\left(R_i, R_S\right)$$

- *Marginal* density is $f(R_i)$, and the two *conditional* densities are $f\left(R_i|R_S\right)$ and $f\left(R_S|R_i\right)$
- *VaR*, (where Q is a quantile)

$$\mathrm{pr}[R_i \leq Q_i] = p$$

Common measures

these things are much more similar than often maintained

Marginal risk measure	Condition on system	Condition on institution
	MVaR	*CoVaR*
VaR	$\mathrm{pr}[R_i \leq Q_i \vert R_S \leq Q_S] = p$	$\mathrm{pr}[R_S \leq Q_S \vert R_i \leq Q_i] = p$
	MES	CoES
ES	$\mathrm{E}[R_i \vert R_S \leq Q_S]$	$\mathrm{E}[R_S \vert R_i \leq Q_i]$

- Other measures like Shapley fit into this
- *All depend on daily VaR* and have more model risk than VaR

Data

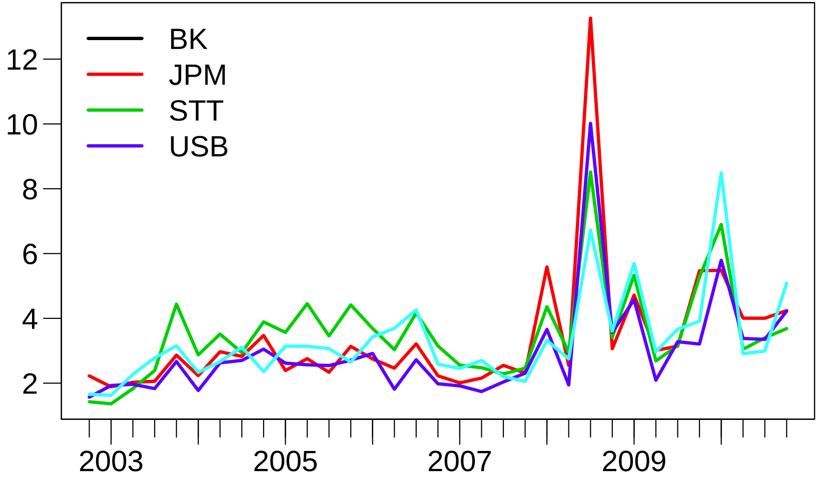
- Daily total returns January 1997–December 2010 (+ some state variables for CoVaR)
- 92 largest US financial institutions
- Here four representative stocks: Bank of New York Mellon (BK), JP Morgan Chase& Co. (JPM), State Street (STT) and US Bancorp (USB)
- Full results and all code for estimation can (will) be found in the Webappendix, `www.RiskResearch.org/sysrisk`

VaR

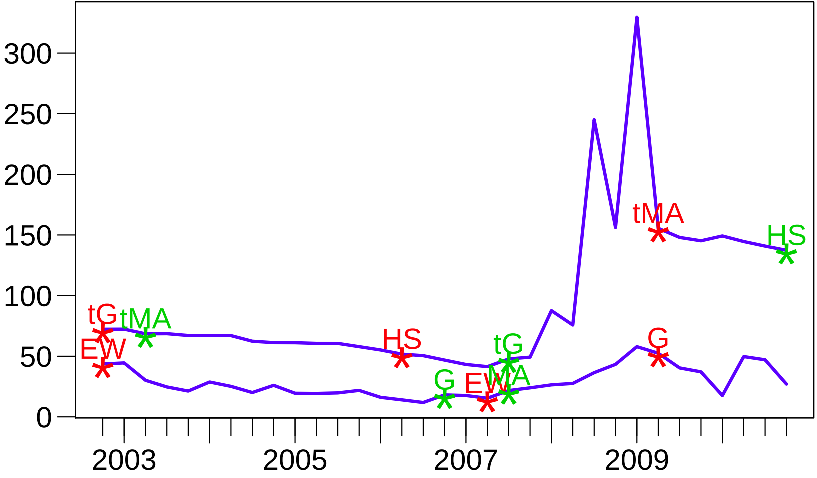
- Forecast 99% VaR with the most widely used state–of–the–art methods
  - HS, MW, student-t MW, EWMA, GARCH and student-t GARCH
  - Range of estimation windows (500, 1000, 1500)
  - $1000 portfolio

Ratio of highest to lowest daily 1% VaR

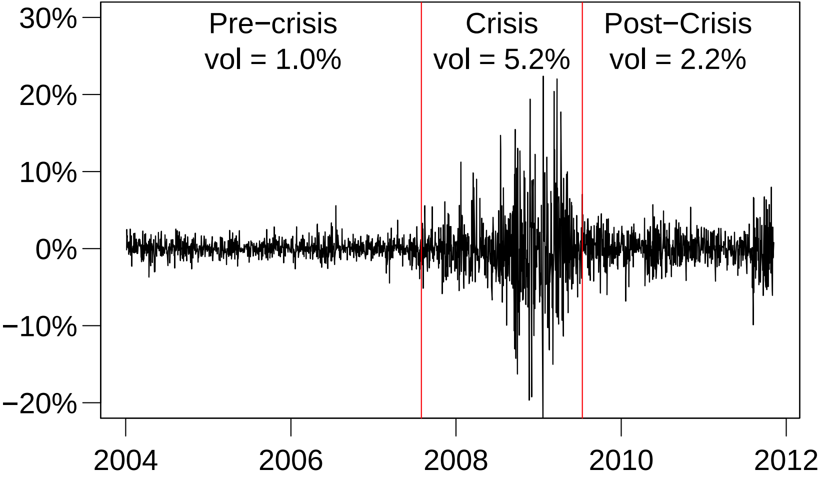
End of quarter results. Probability is 1%



JP Morgan highest and lowest VaR



Usefulness of pre-crisis data: JPM



Immediate conclusion

- State–of–the–art market risk models are highly inaccurate
- Just by tweaking the model I can make VaR be \$100, \$200 or \$300, using only models accepted by the supervisors
- Model risk much higher during extreme turmoil
- Model risk much higher at systematically important probabilities
- To me this suggests market risk approaches are not appropriate for systemic risk

Analysis

When risk is created

Former head of the BIS, Andrew Crockett in 2000

"The received wisdom is that risk increases in recessions and falls in booms. In contrast, it may be more helpful to think of risk as increasing during upswings, as financial imbalances build up, and materialising in recessions."

Assumptions behind almost every risk and pricing model known

Joint with Hyun Song Shin and Jean–Pierre Zigrand

- Risk is *exogenous* (we are strictly price takers)
- Market prices are the best reflection of value
- Today's price has most information

If true, consequently

- The best way to forecast risk (even prices) is to combine a *historical sample* of prices
  - With a model like EWMA, HS, IV, GARCH, etc. ...
- Best to *down weigh history*
- Price dynamics in a crisis belong to the *same stochastic process* as price dynamics outside of crisis

However . . .

- Risk is really *endogenous*
- Prices reflect *constraints* (margins, capital, politics, etc.)
- These effects are stronger during crises
- Forces driving prices and risk are different in a crisis than out of crisis
- The underlying economic process may be the same, but we are talking statistics

Dual role of prices

- They are a passive reflection of the underlying economic fundamentals, an aggregation of all available information but on the other
- Also an imperative to action
- Implications (see next slide)

Role of prices

- Market prices during periods of calm are a poor input into forecast models
- They are not informative about the distribution of prices that follow after a crisis is triggered
- Price dynamics during one crisis may be quite different in the next, limiting the ability to draw inference from crisis events

Risk models underestimate risk during calm times and overestimate risk during crisis — they get it wrong in all states of the world

Systemic risk forecasting

- Market variables as indication of the risk of future systemic event
- Systemic risk is concerned with events that happen during crisis conditions, looking far into the tails of distributions
  - Little relevant data
  - Over the last fifty or so years we have observed less than a dozen episodes of extreme international market turmoil, all unique
  - Models that are fed with inputs from calm periods will perform much less well during periods of stress

Quality control for systemic risk measures

1. Point forecasts are not sufficient: need *confidence intervals* incorporating both estimation risk and model risk
2. Data should be *predictive* and not reactive
3. Statistical method needs to include *backtesting*
4. Event probabilities need to correspond with the probability of systemic events
    - If such events happen once every 10 years, 99% probabilities (2.5 times a year) are of little relevance
    - One *can not* map failure probabilities from less extreme to more extreme. (estimate at 99% use for 99.9%)

Is a bad systemic risk measure better than none?

- Current systemic risk measures are quite bad, perhaps indistinguishable from random noise or at best weakly better in prediction
- High cost of using an incorrect method
- A bad systemic risk measure should not be acceptable for policy purposes, it should be of a proven quality
- *Type 2 errors are very costly* (falsely finding high sysrisk)
- Avoid the fallacy of requiring a number for decision–making regardless of the number quality

So . . .

- A different class of models (currently mostly nonexistent) is required to forecast *extremes* or *crises* or *systemic risk*
- From a fundamental economic point of view the financial system may follow the same economic process over time
- From a practical and statistical point of view the *stochastic processes are different* in crisis and non–crisis
- Each crisis event has different statistical properties
- Systemic risk modelling is in its infancy